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Hydrology and Earth System Sciences Discussions

Interactive comment on "Operational hydrological data assimilation with the Retrospective Ensemble Kalman Filter: use of observed discharge to update past and present model states for flow forecasts" *by* H. K. McMillan et al.

Anonymous Referee #1

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General Comments:

This paper has applied the Retropsective Ensemble Kalman Filter (REnKF) to assimilate hourly stremflow into the TopNet model and compared its performance to the Ensemble Kalman Filter (EnKF). Modeling results were presented to illustrate the impact of incorporating a Lag Time parameter to account for the time of concentration, the time taken for the watershed to respond to precipitation event. As a result, this paper presents no new methods but an assessment of existing methods in several regional

watersheds and findings on the rationale for different accuracy levels in the REnKF and the EnKF. The authors have provided detailed information to reproduce their experiment, but the grammar and coherence of sentences should be improved in some sections.

a). The comparisons made between REnKF and EnKF are based on flow estimations at the update time step; but it is important to examine the accuracy of the estimations for different lead times, e.g., 6-hour, 12-hour, 24-hour ahead, etc. In other words, how will the two methods perform for future time steps? This is important for operational streamflow forecasts.

b). The evaluation of the estimated streamflow should include the percentage bias, which gives information about the proportion of the observed streamflow that is in error or not predicted. It is widely known that large streamflows have a distortional impact on Nash Sutcliffe score, the inclusion of percentage bias is an important volumetric measure.

c). The conclusions drawn in 'sensitivity to error parameters' section is inadequate. To test for sensitivity for your chosen parameters, you need to evaluate for each parameter the distribution of its values using the ensemble members for the entire assimilation time steps and across the various watersheds. That way, you can determine if there are differences or commonalities between watersheds for each parameter. Additionally, the authors try to isolate the spread in the ensemble predictions to individual model states. But the evaluation procedure is not comprehensive: these evaluations require extended time periods across the various watersheds than as shown in the results.

d). Page 9540, lines 8-10: it is okay that you use an ensemble size of 50 but the reason is vague. The ensemble size is usually chosen to adequately represent the number of parameters, and to sufficient for your problem.

e). Page 9542, lines 13-16: did you mean the M was chosen to be 1, which is same as the observation time step?

f). Page 9544, lines 3-5: In other words, model parameters were not modified between assimilation time steps?

g). Page 9547, lines 4-5 and Figure 6: the 'spikes' it was referred to in the EnKF mostly occur when model states for distorted by the observation data from previous assimilation time step. This distortion occurs when the observation data overwhelms the update time step where the observation drives the update towards itself. The REnKF in this case, provides a modulating/balancing effect to minimize the error.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 9533, 2012.